



Florida Trends and Conditions

2000 – 2001



Trends in Transportation and Ecosystems

Prepared for:
Florida Department of Transportation

Prepared by:



June 2001

REPRODUCED BY:
U.S. Department of Commerce
National Technical Information Service
Springfield, Virginia 22161



Reproduced from
best available copy.



***PROTECTED UNDER INTERNATIONAL COPYRIGHT
ALL RIGHTS RESERVED
NATIONAL TECHNICAL INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE***

Photo Credits:

*Cover Images courtesy of the South Florida Water Management District and
The FAU/FIU Joint Center for Environmental and Urban Problems*

Florida Trends and Conditions 2000- 2001

Trends in Transportation and Ecosystems

FM 405810
Contract No. BC-852
Trends and Conditions Research

Prepared for:
Florida Department of Transportation

Prepared by:

Jaap Vos, Ph.D.
Stella Quintero

Florida Atlantic University/Florida International University
Joint Center for Environmental and Urban Problems

June 2001

Table of Contents

List of Figures and Tables.....	2
Executive Summary	3
Habitat Loss	7
Habitat Fragmentation.....	10
Endangered and Exotic Species	11
Legislation.....	14
Endangered Species Act	14
The National Wild and Scenic Rivers Act	15
National Environmental Policy Act.....	16
ISTEA and TEA-21	16
Effects of Transportation on Wildlife and Habitat	18
Road Impacts to Wildlife and Habitat	19
The Everglades: A Special Case.....	21
Conclusion and Discussion	22
References.....	23

List of Figures and Tables

Table 1: Endemism in Florida's Natural Systems.	6
Table 2: Some of Florida's More Unique Historical Features at the Community/Ecosystem Scale.	7
Figure 1: Change in Acres of Forests and Wetlands 1936-1987.....	8
Table 3: Extent of Temporal Changes in Some of Florida's Communities/Ecosystems.	9
Table 4: State Acquired Lands.	10
Table 5: Endangered and Threatened Species in Florida.	12
Table 6: Estimated Acreage of Water Hyacinth and Hydrilla Infestation.....	13

Executive Summary

Florida supports a diverse and unique combination of ecosystems and has more species than any other state east of the Mississippi. At the same time, 516 species in Florida are listed as endangered or threatened and Florida is home to 4 of the 10 most endangered species in the US. Because of its climate Florida is also extremely vulnerable to exotic species that often out-compete native species and change ecosystems.

The main threat to ecosystems and wildlife in Florida is the loss of natural habitat due to increased urbanization caused by population pressure. It is estimated that 150,000 acres of Florida land are converted to development each year. Habitat fragmentation poses another threat, especially for those species that need large habitats, such as the Florida Panther and the Black Bear.

To offset the rapid transformation of natural habitats to urban development, the State of Florida has been very active in the acquisition of remaining natural areas. At this point in time, 21 percent of all land in Florida (8.38 million acres) is publicly owned preservation land. These lands represent a foundation for the protection of ecologically sensitive and important communities and species.

The first effect of transportation on the natural system occurs during highway construction. Highway construction may cause changes in turbidity, suspended solids concentration, and color of receiving waters. Temporary storage facilities for equipment and supplies used during the construction phase may also damage vegetation and displace communities of animals. Road transportation infrastructure, such as buildings and bridges, also may have habitat impacts. For example, bridges and stream crossings are likely to have significant impacts on hydrology and aquatic habitat.

The most serious effects on ecosystems are caused by roads and the use of the roads. The most evident impacts of roads on wildlife and habitats include:

1. Roadkill.
2. The fragmentation of habitat.
3. Complication of the management of remaining habitat fragments (e.g., fire management).
4. Changes in animal behavior.
5. Provision of habitat and movement corridors for opportunistic species of plants and animals.
6. Disturbance to wildlife.
7. Displacement of plants and animals.

With growing population in Florida, it is likely that conflicts between preservation and transportation will increase. It is also likely that road designs will increasingly have to include components that can mitigate possible negative effects on wildlife. Given the large number of endangered and threatened species in Florida, the Endangered Species Act could have a substantial effect on the construction of new roads or road widenings. The challenge for Florida is to protect its unique natural resources while providing for its growing population. The challenge for transportation is to provide for mobility for Florida's population while preserving the increasingly sparser natural areas.

Ecosystems and Transportation

Florida is blessed with a wide display of unique habitats and wildlife. Unfortunately, both habitats and wildlife are under pressure due to the conversion of natural lands into cities. With continuing population growth in Florida, natural habitats are likely to continue to diminish and preservation of the wildlife habitat that was once abundant will become more and more critical.¹

The term ecosystem comprises all the relationships between organisms of a given area and their interactions with the physical environment.² Living organisms interact with each other in biotic processes and with non-biological organisms in abiotic processes, such as temperature, rainfall, and soil. These interactions are vital to defining which organisms can live in a given area.³ In Florida, these interactions and other environmental conditions are responsible for the development of distinctive natural communities and plant associations.⁴ The State of Florida encompasses a true natural system, not just an ecosystem with geographic boundaries. This natural system not only is important for local ecosystems in Florida but also plays a significant role in the survival of migratory species such as birds and sea turtles, and links Florida's natural system to other systems in the US and the world.⁵

Florida's natural system supports a great diversity of native plants and animal life and has more wildlife species than any other state east of the Mississippi⁶. It is estimated that there are about 3,500 species of vascular plants, 900 species of non-marine vertebrate animals, as well as thousands of species of invertebrate animals. Among the 900 species are 75 mammals, 283 birds, 127 reptiles, 57 amphibians, and 126 fishes. About 115 (17 percent) of these are not found elsewhere in the United States.

Table 1 shows that many plant and animal species are endemic (present distributions occur entirely within the political boundaries of Florida) or nearly endemic ranges extend only slightly beyond Florida's borders. Most endemic species live in the Central Lake Wales Ridge, the Everglades and Florida Keys, and the Apalachicola River area.

Besides the vast amount of endemic species, Florida also serves as an important natural link between North American and the Caribbean Islands and South America. These international linkages include hundreds of bird species and sea turtles that rely on Florida's natural systems to satisfy nesting, wintering and migration requirements.

Table 1: Endemism in Florida's Natural Systems.⁷

Taxa	Endemic		Nearly Endemic	
	Species	Subspecies	Species	Subspecies
Vascular Plants	235	NA	40	NA
Freshwater Fish	4	3	4	0
Amphibians	1	5	3	1
Reptiles	6	31	2	4
Birds	0	7	0	2
Mammals	2	56	1	2
Terrestrial and Freshwater Invertebrates	410	0	0	0
Plant Communities	13 (of 70)		NA	

Florida's ecosystems are truly unique in the world and they are of great importance not only for the beauty and the meaning of life itself but because they support the life of Floridians and they are the key for sustained growth. Some of the characteristics of Florida's diverse ecosystems are shown in Table 2.

Table 2: Some of Florida's More Unique Historical Features at the Community/Ecosystem Scale.⁸

Natural System Feature	Dimension
Coastline	1,900 km (greater than all other states except Alaska)
Saltmarshes	180,000 ha
Longleaf pine forests	More than 1/5 of the state
Freshwater Wetlands	More than 1/2 of the state
Lakes	7,800 lakes
Rivers	1,700 rivers
Springs	300 springs

Habitat Loss

The main threat to ecosystems and wildlife in Florida is the loss of natural habitat due to increased urbanization caused by population pressure. Nearly 150,000 acres of Florida land are converted to development each year.⁹ While less than 2 percent of land was used for urban purposes in 1936, by 1987 more than 12 percent of Florida was devoted to urban land uses. At the same time forests and wetlands showed sharp declines. According to the Strategic Assessment of Florida's Environment, forest showed a 38 percent decline from 1936 to 1987, while wetlands declined with 28 percent in the same time period¹⁰ (See Figure 1). Although, there is no recent data available on the extend of ecosystem loss, it is likely that natural ecosystems have further declined in size because of the continued urban growth in Florida.

Figure 1: Change in Acres of Forests and Wetlands 1936-1987.



In the face of enormous development pressures, lands for wildlife habitat, recreation, greenspace, and surface water protection are increasingly threatened. The Florida Natural Areas Inventory lists 33 of the state's 70 systems, 47%, as globally rare to critically imperiled and 54 (77%) as state rare or critically imperiled.¹¹ In contrast to most of the other places in the United States, the declines in Florida's natural systems have occurred within this century.¹² A description of changes in Florida's natural systems is shown in Table 3.

The State of Florida has taken a series of initiatives to acquire the most critical resource areas. In the past 20 years, the state has bought over 2.3 million acres of land under the Conservation and Lands Program (CARL), the Save Our Rivers Program (SOR), the Save Our Coast Program (SOC) and the Preservation 2000 Program (P2000) (Table 4).

Table 3: Extent of Temporal Changes in Some of Florida's Communities/Ecosystems.¹³

Community/ecosystem	Description of Change
Seagrass meadows in Tampa Bay	81% reduction from the 1800s
Mangroves in Tampa Bay	7% reduction from 1950 to 1980
Salt marshes in Brevard County	95% were converted to mosquito control impoundments
Salt and freshwater marshes	60% reduction from 1936 to 1987
Everglades system	65% converted into a water control system
Coastal Strand	50% reduction from 1936 to 1987
Pine Rocklands	95% reduction from 1936 to 1987
Tropical Hammocks	50% reduction from 1936 to 1987
Central ridge scrub	82% reduction from 1936 to 1987
Longleaf pine forests	87% reduction from 1936 to 1987 ¹

¹⁾ Only 38% of the remaining longleaf pine forests is in public ownership.

The state currently owns and manages 4.1 million acres of conservation and recreation lands, almost 12 percent of Florida's total land area. This includes lands owned by state agencies and water management districts¹⁴ and represents an extraordinary commitment on the part of the state to the acquisition of environmentally important lands. The federal government in the past has also made substantial acquisitions of endangered areas in the state. Though not as active today, the federal government continues to purchase or assist the state in purchasing critical resource areas.

In 1994, the Florida Game and Fresh Water Fish Commission identified 4.82 million acres of high quality habitat that would meet the needs of 54 species of wildlife and 105 rare plants and designated these lands as Strategic Habitat Conservation Areas. At the time all these lands were in private ownership but since then the state has acquired almost 500,000 acres of these areas. Another 240,000 acres was acquired by the

federal government, meaning that currently about 15 percent of these lands are in public ownership.¹⁵

Table 4: State Acquired Lands.¹⁶

Program	Land preserved (acres)
CARL	345,111
SOR	504,957
SOC	72,732
P2000	1,381,616
TOTAL	2,304,416

Florida's complete system of publicly owned conservation lands now covers 8.38 million acres, over 21 percent of the land area of the state. These lands represent a foundation for the protection of ecologically sensitive and important communities and species.

Habitat Fragmentation

The increased fragmentation of the remaining patches of natural habitat poses an additional threat to wildlife. Habitat fragmentation refers to the tendency for remaining patches of habitat to become reduced in size and isolated from one another. This creates problems since some species require large tracts of habitat to survive. One example of this is the Florida panther, which has a broad habitat preference and at one time ranged throughout Florida. Although the panther preys on a number of species, it depends on the deer population within its hunting range for its reproductive success. The panther is one of the endangered species in Florida and the number of panthers is not likely to exceed twenty based on available habitat.¹⁷

Another effect of habitat fragmentation is the fact that as habitat is lost, the remaining patches tend to become increasingly distant from one another. If patches of appropriate habitat are sufficiently large to support a breeding pair yet are so far apart

that individuals cannot move easily from one patch to another and intermix with other members of the species, then the presence of the species across all remaining patches becomes increasingly unlikely.

Another important factor, related to habitat loss and habitat fragmentation is the creation of edges. With the concept of edge, ecologists refer to the transition between two ecosystems. An edge is the sudden change from one ecosystem to another, or the transition from an ecosystem to an urban area or road. Human activities have greatly increased the number of edges while they have reduced the occurrence of so-called ecotones. In contrast to an edge, an ecotone refers to the gradual transition from one ecosystem to another. An ecotone can describe the transition from open ground to forest, which is marked by a set of environmental gradients such as increased moisture both in air and in the soil, increased amounts of leaf litter and hence soil organic content, as well as decreased light availability, wind speed, temperature, noise, and pollution¹⁸. This ecotone is of great importance because it offers a unique set of habitats and is often an area of considerable species richness. Furthermore, the ecotone supports a portion of the flora and fauna of both open ground and deep forests, and consequently, it may have a higher species diversity than either.¹⁹ Habitat fragmentation increases the occurrence of edges which typically makes ecosystems more vulnerable to weather influences and the invasion of exotic species.

Endangered and Exotic Species

The loss and alteration of habitat has resulted in a dramatic decline of native species and the prolific spread of exotic species. According to recent estimates there are just 50-60 Florida Panthers left, wading bird populations have declined with 90 percent and 68 plant and animal species in the Everglades are listed as endangered or threatened²⁰. Four of the ten most endangered species in the United States can be found in Florida: the American Crocodile, the Florida Panther, Key Deer and the West Indian Manatee.²¹ Florida is home to a total of 561 endangered or threatened species.²² Table 5 shows that although 457 of the endangered and threatened species are plants, mammals

seem to be most threatened with 57 percent of the mammals in Florida being listed as either endangered or threatened. In addition, according to the Florida Assessment of Coastal trends report, forty-four percent of all Florida's vertebrates are known or suspected to be declining in number or distribution.

Table 5: Endangered and Threatened Species in Florida.²³

Species	Total	Endangered/Threatened	Percentage Endangered/Threatened
Vascular plants	3500	457	13 %
Fish	126	8	6 %
Amphibians	57	0	-
Reptiles	127	10	8 %
Birds	283	33	12 %
Mammals	75	43	57 %
Invertebrates	Unknown	10	n.a.

Genetic diversity has also been reduced in species with small remainder populations such as the panther. When human induced changes occur, the species that are least adaptable to change are extirpated first. If conditions continue to get worse, fewer and fewer species can be sustained until all that remain are the very adaptable, generalist species, such as raccoons, gulls, and cockroaches.²⁴ Introduction of exotic species is also observed in Florida. This leads to a very low, homogeneous diversity of life in Florida, and it means that some generalist species that did not originally live in the area may move into niches formerly occupied by extirpated species.

The ecosystems in tropical and subtropical regions are vulnerable to disturbances and invasion by introduced non-indigenous plant species. It is estimated that about 1000 of the approximate 3500 plant species in Florida are exotics.²⁵ These plants place a great deal of stress on Florida's unique and irreplaceable ecosystems.²⁶ Melaleuca is probably Florida's most destructive exotic plant species. Melaleuca trees can consume as much as 2200 gallons of water per acre per hour.²⁷ It was introduced in south Florida from its native Australia in the early 1900s to aid in the drainage of the

Everglades. The tree has no native pests and tolerates droughts, floods and fires enabling it to spread prolifically throughout south Florida.

Exotic plant species are not the only problem in Florida, exotic fauna also causes problems. The Giant South American Marine Toad rapidly established itself in south Florida and now threatens to out-compete the native southern toad. The non-native walking catfish has established itself from central Florida to the most southern tip of the peninsula and competes for food with other fresh water fish. The Asian Swamp Eel is one of the latest threats, which potentially can wreak havoc in the fresh water communities.

Table 6: Estimated Acreage of Water Hyacinth and Hydrilla Infestation.²⁸

Year	Water Hyacinth	Hydrilla
1986	2700	13000
1987	3900	15200
1988	2000	12500
1989	1900	10700
1990	600	10600
1991	1100	9500
1992	1000	7400
1993	1100	9500
1994	900	10900
1995	1300	6000
1996	1000	4300

Because of its warm climate and abundance of aquatic habitats, Florida is particularly susceptible to infestations of exotic aquatic and wetland plants. Florida's large exotic aquarium plant and ornamental foliage industry imports millions of non-native species each year, but unfortunately many of those have escaped or been

accidentally introduced.²⁹ Two non-indigenous aquatic plant species of particular concern in Florida are hydrilla and water hyacinth.³⁰ Table 6 shows the number of acreage of hydrilla and water hyacinth infestation.

Everglades National Park alone has been invaded by over 220 exotic plant species. The main problem species are Melaleuca, Brazilian Pepper, Australian Pine and Hydrilla, all of which are widespread and have replaced native species.

Legislation

Endangered Species Act

In 1973, the United States government passed the Endangered Species Act. This was the first major law to protect animals threatened with extinction, and the only one that has authority to stop any project that jeopardizes the habitat of endangered species. This Act seeks to conserve endangered and threatened species through requiring federal agencies to ensure that their actions “do not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modifications of the critical habitat of such species.”³¹ An endangered species is “any species which is in danger of extinction throughout all or a significant portion of its range.”³² A threatened species is that which is “likely to become an endangered species within the foreseeable future through all or significant portion of its range.”³³ A “species” includes any species or subspecies of fish, wildlife, or plant; any variety of plant; and any distinct population segment of any vertebrate species that interbreeds when mature. Excluded is any species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of the Act would present an overwhelming and overriding risk to man.³⁴

When a species is listed under the Endangered Species Act, the lead federal agency is required to issue a biological assessment whenever an action in which the federal government is involved “may affect” a listed or threatened species.³⁵ If the results of the biological assessment show that a listed species may be affected by the

project, the agency must consult with the Fish and Wildlife Service. In the case that a species would be affected, the lead agency must provide mitigation measures for, or alternatives to, the proposed activity.³⁶ Even if a “water right” exists, projects that affect such areas may be subject to Endangered Species Act regulation. Even though it is not very clear whether state water law and water rights are protected from Endangered Species Act regulation, the case law indicates that the Endangered Species Act does authorize a reduction in the power of existing water rights through regulation.³⁷

Highway construction, runoff quality, mitigation activities, and maintenance may be subject to review under the Endangered Species Act if the receiving waters are considered “critical habitats.” The Endangered Species Act applies to activities directly affecting water resources designated as “critical habitat” areas, and may include receiving waters from highway or urban runoff.

The National Wild and Scenic Rivers Act

The purpose of this Act is limited to the protection of “*certain selected rivers of the Nation, which, with their immediate environments possess outstandingly remarkable qualities.*”³⁸ It essentially provides a mechanism to determine if a river can meet certain eligibility requirements for protection as a wild and/or scenic river, and protects designated rivers from activities which may adversely impact those values.³⁹ The Department of Agriculture administers and designates rivers in the national forests,⁴⁰ even though the Act’s framers intended for most private land’s rivers to enter the Wild and Scenic River System through the State designation and management provisions.⁴¹

As of 1993, 32 states have conservation programs of some form where rivers and their environments are protected under State Wild and Scenic River legislation. As a result, many state regulations prohibit or restrict dams, protect designated rivers from canalization or diversion, or have instituted comprehensive controls for land use planning, water quality and waste-control, transportation planning and local zoning requirements. Highway construction and operations near designated river segments are

subject to restrictions developed by the state. Even if such activities are temporary, any disruptions to the normal flow of the river, increased sediment loads, or significant increases to pollutant loads, may be restricted by state-enacted Wild and Scenic Rivers Act.⁴²

National Environmental Policy Act

The National Environmental Policy Act (NEPA) was designed to create a vehicle for considering environmental amenities consistent with other national needs, such as economic development, in a systematic manner.⁴³ NEPA establishes judicially enforceable obligations which require all federal agencies to identify the environmental impacts of their planned activities. Under the Act, federal agencies are required to determine whether a proposed action constitutes a “major Federal action which will significantly affect” the quality of the human environment.⁴⁴ The organization has to conduct a preliminary investigation of the potential environmental effects and report it in an environmental assessment (EA), or an environmental impact statement (EIS), in order to determine if further investigation is required. NEPA requires federal agencies to conduct preliminary environmental impact analysis as early in the planning process as possible, and prior to the undertaking of the project or action.

Highway operations and projects are subject to the NEPA process and environmental concerns must be considered before implementation. The NEPA legislation is the protector under which environmental impacts are evaluated for all substantial federal projects.

ISTEA and TEA-21

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) includes measures and policies requiring or encouraging an approach to transportation development which integrates considerations for management of both the natural and

constructed environments. ISTEA, through measures in the Transportation Improvement Program, encourages Metropolitan Planning Organizations, local, and state transportation agencies to involve the public and other resource management and development concerns in long-range transportation planning. It also requires that transportation agencies consider the likely effects of transportation policy decisions on land use and development, and the consistency of transportation plans and programs with the provisions of all applicable short- and long-term land use and development plans. In a sense, these provisions incorporate an ecosystem approach into highway planning, resource development, and land-use by moving land use decisions to the front end of the transportation planning process. This should encourage better decision-making processes and long range planning for both transportation and land use development compatible with sustainable ecosystem productivity and integrity.

ISTEA provides clear and specific authority for advance inventory of wetlands resources, participation in local and regional planning efforts for management of wetlands ecosystems, and development of mitigation banks for mitigation of unavoidable wetlands impacts. It also establishes the eligibility of mitigating impacts on other natural ecosystems and wildlife habitat for federal-aid funding. All of these approaches support an ecosystem management concept.

TEA-21 builds upon the planning provisions of ISTEA to assure that environmental considerations are part of the decision making process. Although it increases funding for the Congestion Mitigation and Air Quality Improvement as well as the Transportation Enhancements Programs, TEA-21 does not include specific provisions for ecosystem protection and ecosystem management but does call for environmental streamlining and better integration of transportation and community planning.⁴⁵

Effects of Transportation on Wildlife and Habitat

Introducing roads and associated infrastructure into the environment has led to the destruction or disruption of habitats in the right-of-way. Roads damage existing vegetation, interfere with wildlife crossings, displace forests and communities of animals and birds, and alter the hydrology of various areas, including drainage, permeability, and stream flow patterns.⁴⁶

Highway construction has also been cited as an activity that contributes to wetlands destruction and loss of mangroves, seagrass, marshes, and swamps –habitats that support a diverse range of species and provide other desirable functions such as flood control.⁴⁷ In the past 200 years, the U.S. has lost over half of the original wetlands acreage in the 48 contiguous states. In recent years, 300,000 acres have been lost annually, or a 3 percent loss per decade. Over half of these recent losses have been caused by conversion to agricultural use, and only 4 percent were identified as conversion to urban land. The amount of wetlands acreage lost annually is over 20 times higher than the amount of new land used by roads.⁴⁸

According to the Florida Department of Transportation, over the last 50 years Florida's high-speed paved roads have increased at the rate of 4.5 miles per day. The newest roads are all the more damaging because they are wider and allow even faster travel. These and other barriers make it difficult for animals to use all parts of their habitat. Sometimes populations are trapped in areas too small to support them. This is especially true of species such as bears that require a wide range. Confined to inadequate space, the animals are likely to be wiped out by natural disasters such as floods, fires, too much heat or too much cold.⁴⁹

Construction of roads can also reduce water storage and spring flow, threatening species during droughts. When natural ground cover is present over an entire site, normally less than ten percent of the storm-water runs off into nearby rivers and lakes. As paved surfaces increase, both the volume and rate of runoff increase. When paved surfaces cover ten to thirty percent of the site area, approximately twenty percent of the

storm-water can be expected to run off.⁵⁰ Pollutants washed from land surfaces and are carried to lakes and rivers by runoff, which may add to existing water quality problems. In addition, paved surfaces prevent natural infiltration of storm-water into the ground.

Other road transportation infrastructure, such as buildings and bridges, also may have habitat impacts. For example, bridges and stream crossings are likely to have significant impacts on hydrology and aquatic habitat. However, the physical extent of roads is far greater than that of buildings and bridges.⁵¹

The environmental impact of a particular project depends on the location and condition of the surrounding area, the size and type of road constructed, and the duration of the project. The construction of the facility itself may cause changes in turbidity, suspended solids concentration, and color of receiving waters. Temporary storage facilities for equipment and supplies used during the construction phase may also damage vegetation and displace communities of animals. However, it is important to keep in mind that it is very difficult to isolate from the effects of land-use changes, socioeconomic changes, and natural ecological changes in receiving water bodies.⁵²

Florida's rapidly growing population is causing increasing demands on natural systems. Urban water uses are drastically rising, and urban sprawl is fragmenting and degrading habitats. Due to the relationship between the environment and our economy, environmental damage harms the economy. The value of protecting Florida's environment, however, cannot be readily measured in dollars, because the benefits of a functioning environment are not adequately valued under our current method of economic accounting. Besides, many benefits of environmental protection are intangible or aesthetic.⁵³

Road Impacts to Wildlife and Habitat

Roads fragment landscapes may become a barrier to dispersal, both because they are an alien surface and also because animals may be killed crossing the road.⁵⁴ The most evident impacts of roads on wildlife and habitats can be categorized as follows:

1. Roads cause direct animal mortality through collisions with vehicles (roadkill).
2. Roads expedite the conversion of surrounding lands to development.
3. Roads fragment wildlife habitat, isolating populations and decreasing the chances of survival of the fragments.
4. Roads complicate the management of remaining habitat fragments (e.g., fire management), compromising the quality of the habitat and its value to wildlife.
5. Roads alter animal behavior by causing changes in home ranges, movement, reproductive success, escape response, and physiological state.
6. Roads may provide habitat and movement corridors for opportunistic species of plants and animals. Roads can provide corridors of disturbance and seed transport for exotic species of plants.
7. Roads increase human access to natural areas, increasing disturbance to wildlife.
8. Roads affect the physical environment: change the soil density, temperature, soil water content, light levels, surface waters, patterns of runoff, sedimentation, and create dust in their immediate environment.
9. Roads affect the chemical environment: add heavy metals, salts, organic molecules, ozone, and nutrients to roadside environments.
10. Roads pollute air and water, and impair aquatic ecosystems.
11. Road construction displaces and kills plants and animals.

Pollution from roads begins with construction. An immediate impact is noise from construction equipment, and noise remains a problem along highways with heavy traffic. Animals respond to noise pollution by altering activity patterns, and with an increase in heart rate and production of stress hormones. Sometimes animals become habituated to increased noise levels, and apparently resume normal activity. But birds and other wildlife that communicate by auditory signals may be at a disadvantage near roads. Highway noise can also disrupt territory establishment and defense.⁵⁵

Many studies have documented increasing levels of lead in plants with proximity to roads, and with increases in traffic volume.⁵⁶ Plant roots take up lead from the soil and leaves take it up from contaminated air or from particulate matter on the leaf surface.

This lead moves up the food chain, with sometimes-severe toxic effects on animals, including reproductive impairment, renal abnormalities, and increased mortality rates. Less is known about the effects of other heavy metals, such as zinc, cadmium and nickel. Motor oil and tires contain zinc and cadmium; motor oil and gasoline contain nickel. These metals like lead, have been found to increase with proximity to roads, and with increasing traffic volume and decreasing soil depth. Earthworms have been found to accumulate all these metals in concentrations high enough to kill earthworms-eating animals. These roadside contaminants can be carried far from roads by wind and water.⁵⁷

The Everglades: A Special Case

Although ecosystems fragmentation is a problem that affects the whole state of Florida, the Everglades are of special consideration due to its uniqueness and influences over the fastest growing South Florida. The wildlife habitat value of the Everglades wetland system as a whole is extremely important. It serves as a permanent refuge for a great diversity of wildlife including numerous endangered species.⁵⁸

The Everglades and South Florida ecosystem in general are uniquely dependent on the area's distinctive water flow pattern.⁵⁹ When people began to disrupt this pattern, the health of the ecosystem began to deteriorate.⁶⁰ The wetlands of South Florida were regarded as being inhospitable and without intrinsic value. In the early 1900's, draining the wetlands was considered to be essential for commerce and safety. Drainage projects were accelerated by the result of hurricanes in the 1920's. Nowadays, much of South Florida's wetlands are intensively managed, with more than 1,400 miles of primary canals and more than 100 water control structures.⁶¹ The effects of the drainage and development of the region include a variety of environmental problems such as loss of soil, nutrient enrichment, contamination by pesticides, mercury buildup in the biota, fragmentation of landscape, loss of wetlands and wetland functions, widespread invasion by exotic species, increased algal blooming in coastal waters, seagrass die off, and declines in fishing resources.⁶²

In addition, the hydrologic changes have disrupted wading bird nesting, which depends on concentrated food supplies that occur under normal dry-season conditions.⁶³ Loss of wetlands in South Florida has also reduced landscape heterogeneity, habitat options, and long-term population survival for animals with large spatial requirements. Wading birds, snail kites, and panthers, for instance, have become increasingly stressed by the fragmentation and loss of habitat.⁶⁴

The Everglades possesses a great biological significance while its effects on the economy of South Florida cannot be ignored. If current patterns of damage continue in the Everglades, area officials have warned that the economic impact could be substantial.⁶⁵

Conclusion and Discussion

With the growing population in Florida it is likely that conflicts between preservation and transportation will increase. It is also likely that road designs will increasingly have to include components that can mitigate possible negative effects on wildlife. Given the large number of endangered and threatened species in Florida, the Endangered Species Act could have a substantial effect on the construction of new roads or road widenings. The challenge for Florida is to protect its unique natural resources while providing for its growing population. The challenge for transportation is to provide for mobility for Florida's population while preserving the increasingly sparser natural areas.

References

-
- ¹ Florida Department of Transportation, 1992. *Project Development and Environmental Manual Part 2*. Florida Department of Transportation.
- ² Bush, Mark, 2000. *Ecology of a Changing Planet*. 2nd ed. Prentice Hall, New Jersey.
- ³ *Ibid.*
- ⁴ Schaefer, J., 2000. *Florida Natural Systems: Diverse and Valuable Resources*.
- ⁵ *Ibid.*
- ⁶ Florida Conservation Foundation, 1993. Guide to Florida Environmental Issues and Information. Florida Conservation Foundation, Winter Park, Florida, page 29.
- ⁷ Schaefer, J., 2000. *Florida Natural Systems: Diverse and Valuable Resources*. Department of Wildlife Ecology and Conservation.
- ⁸ *Ibid.*
- ⁹ *Ibid.*
- ¹⁰ Florida Department of Environmental Protection, 1994. *Strategic Assessment of Florida's Environment*, DEP, Tallahassee, FL.
- ¹¹ Schaefer, J., 2000. *Florida Natural Systems: Diverse and Valuable Resources*. Department of Wildlife Ecology and Conservation.
- ¹² *Ibid.*
- ¹³ *Ibid.*
- ¹⁴ Florida Legislature, Office of Program Policy Analysis and Government Accountability (2001). *Justification Review State Lands Program Florida Department of Environmental Protection*. Report no 01-07, page 18.
- ¹⁵ *Ibid.* page 22
- ¹⁶ based on: Florida Legislature, Office of Program Policy Analysis and Government Accountability (2001). *Justification Review State Lands Program Florida Department of Environmental Protection*. Report no 01-07, page 17.
- ¹⁷ Belden, R.C. 1982. *Florida Panther Recovery Plan Implementation*. 1982 Progress Report. Florida Game and Freshwater Fish Commission, Gainesville, Florida.
- ¹⁸ Bush, Mark, 2000. *Ecology of a Changing Planet*. 2nd ed. Prentice Hall, New Jersey.

¹⁹ *Ibid.*

²⁰ U.S. Army Corps of Engineers and South Florida Water Management District 2000. *Rescuing an Endangered Ecosystem: The Plan to Restore America's Everglades*, page 7; World Resources Institute 2000. *World Resources 2000-2001: People and Ecosystems, The Fraying Web of Life*. World Resources Institute, Washington, D.C., page 170.

²¹ Florida Conservation Foundation, 1993. Guide to Florida Environmental Issues and Information. Florida Conservation Foundation, Winter Park, Florida, page 33.

²² Number based on U.S. Fish and Wildlife Service publications 50 CFR 17 and 50 CFR.

²³ *Ibid.*

²⁴ Bush, Mark, 2000. *Ecology of a Changing Planet*. 2nd ed. Prentice Hall, New Jersey.

²⁵ Florida Conservation Foundation, 1993. Guide to Florida Environmental Issues and Information. Florida Conservation Foundation, Winter Park, Florida, page 105.

²⁶ Florida Center for Public Management, 1997. *Florida Assessment of Coastal Trends*, Florida Center for Public Management.

²⁷ Florida Conservation Foundation, 1993. Guide to Florida Environmental Issues and Information. Florida Conservation Foundation, Winter Park, Florida, page 106.

²⁸ *Ibid.*

²⁹ Florida Center for Public Management, 1997. *Degradation and restoration of Coastal Ecosystems*, Florida Center for Public Management.

³⁰ *Ibid.*

³¹ 16 U.S.C. –1536

³² 16 U.S.C. –1532

³³ *Ibid.*

³⁴ *Ibid.*

³⁵ *Ibid.*

³⁶ R.A Corbitt, 1990. *Standard Handbook of Environmental Engineering*. MacGraw Hill, Inc. New York, NY, page 628.

³⁷ B. Doppelt, M.Scurlock, C. Frissell, and J. Karr, 1993. *Urban Highway Storm Drainage Model*. Federal Highway Administration. FHWA-RD 83/041-047, Camp Dresser and McKee, Inc., Annandale, VA.

³⁸ 16 U.S.C –1271-1287

³⁹ R.A Corbitt, 1990. *Standard Handbook of Environmental Engineering*. MacGraw Hill, Inc. New York, NY, page 628.

⁴⁰ *Ibid.*

⁴¹ B. Doppelt, M.Scurlock, C. Frissell, and J. Karr, 1993. *Urban Highway Storm Drainage Model*. Federal Highway Administration. FHWA-RD 83/041-047, Camp Dresser and McKee, Inc., Annandale, VA.

⁴² Federal Highway Administration, 1996. *Evaluation and Management of Highway Runoff Water Quality*. Federal Highway Administration.

⁴³ R.A Corbitt, 1990. *Standard Handbook of Environmental Engineering*. MacGraw Hill, Inc. New York, NY, page 628.

⁴⁴ Doppelt, M.Scurlock, C. Frissell, and J. Karr, 1993. *Urban Highway Storm Drainage Model*. Federal Highway Administration. FHWA-RD 83/041-047, Camp Dresser and McKee, Inc., Annandale, VA.

⁴⁵ U.S. Department of Transportation, 1999. *Listening to America*, Report on the U.S. Department of Transportation's Outreach on Implementation of the Transportation Equity Act for the 21st Century (TEA-21)

⁴⁶ Policy Planning & Evaluation (2126), EPA 230-R-96-009, 1996. *Indicators of Environmental Impacts of Transportation*. EPA, United States.

⁴⁷ W.C. Hall and S.M. Naik, 1989. *Determination of effectiveness of Required Environmental Mitigation Activities Related to the Construction of Highways in Florida*, Florida Department of Transportation, University of Florida, FL/DOT/SMO/-89-347, Gainesville, FL.

⁴⁸ *Ibid.*

⁴⁹ Greene, Juanita, Spring 1993. *Florida's Battered Bruins*, Defenders.

⁵⁰ M.E. Barret, R.D. Zuber, E.R. Collins, R.J. Charbeneau, and G.H. Ward, 1993. *A Review and Evaluation of Literature Pertaining to the Quantity and Control of Pollution from Highway Runoff and Construction*, Center for Research in Water Resources, Bureau of Engineering Research, University of Texas at Austin, Austin, TX.

⁵¹ Policy Planning & Evaluation (2126), EPA 230-R-96-009, 1996. *Indicators of Environmental Impacts of Transportation*. EPA, United States.

⁵² *Ibid.*

⁵³ Florida Department of Transportation, 1992. *Project Development and Environmental Manual Part 2*. Florida Department of Transportation.

-
- ⁵⁴ Bush, Mark, 2000. *Ecology of a Changing Planet*. 2nd ed. Prentice Hall, New Jersey.
- ⁵⁵ M.E. Barret, R.D. Zuber, E.R. Collins, R.J. Charbeneau, and G.H. Ward, 1993. *A Review and Evaluation of Literature Pertaining to the Quantity and Control of Pollution from Highway Runoff and Construction*, Center for Research in Water Resources, Bureau of Engineering Research, University of Texas at Austin, Austin, TX.
- ⁵⁶ *Ibid.*
- ⁵⁷ *Ibid.*
- ⁵⁸ *Ibid.*
- ⁵⁹ World Resources Institute, 2000. *World Resources 2000-2001: People and Ecosystems, Fraying Web of Life*, pp. 163-175.
- ⁶⁰ *Ibid.*
- ⁶¹ McPherson, Benjamin and Halley, Robert, 1996. *The South Florida Environment*, U.S. Geological Survey, United States Government Printing Office.
- ⁶² *Ibid.*
- ⁶³ Kushlan, J.A., 1991. The Everglades, in Livingston, R.J., ed., *The rivers of Florida: Ecological Studies 83*. New York, Springer-Verlag, pp. 121-142.
- ⁶⁴ Robertson, W.B., and Frederick, P.C., 1994. *The faunal chapters—Context, synthesis, and departures*. Everglades—The ecosystem and its restoration: Delray Beach, Fla., St. Lucie Press, pp. 709-737.
- ⁶⁵ World Resources Institute, 2000. *World Resources 2000-2001: People and Ecosystems, Fraying Web of Life*, pp. 163-175.

